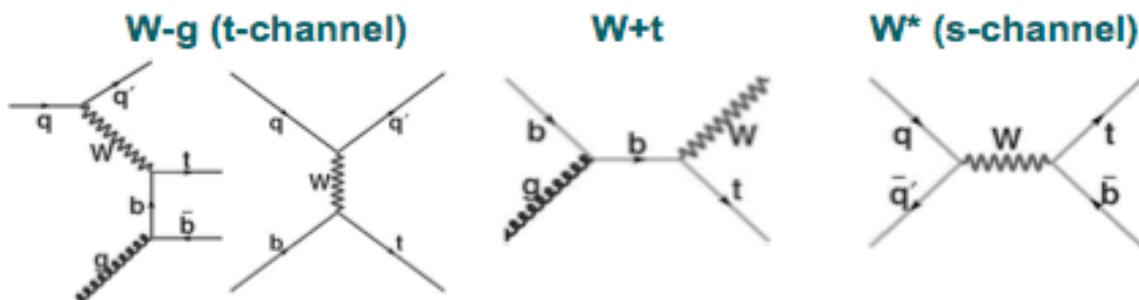


Single Top CSC Note status report

Simona Rolli
Tufts University

Single Top Production at LHC



Properties of the Wtb vertex :

- Determination of $\sigma(pp \rightarrow tX)$, $\Gamma(t \rightarrow Wb)$
- Direct determination of $|V_{tb}|$
- Top polarization

• Precision measurements \rightarrow probe to new physics

- Anomalous couplings
- FCNC
- Extra gauge-bosons W' (GUT, KK)
- Extra Higgs boson (2HDM)

t-channel, Wt

s-channel

$\sim 2 \times 10^6$ events/yr in low luminosity runs

• Single-top is one of the main background to ...

... Higgs physics...

| $M(\text{top}) = 175 \text{ GeV}/c^2$ | | s-channel | t-channel | Associated tW | Combined (s+t) |
|---------------------------------------|-----|----------------------------|----------------------------|----------------------------|----------------|
| TeVatron σ_{NLO} | | $0.88 \pm 0.11 \text{ pb}$ | $1.98 \pm 0.25 \text{ pb}$ | 0.1 pb | |
| LHC σ_{NLO} | | $10.6 \pm 1.1 \text{ pb}$ | $247 \pm 25 \text{ pb}$ | 62^{+17}_{-4} pb | |
| Run II | CDF | $< 3.2 \text{ pb}$ | $< 3.1 \text{ pb}$ | NA | < 3.5 |
| 95% CL | D0 | $< 5 \text{ pb}$ | $< 4.4 \text{ pb}$ | NA | NA |

$$\sigma_{t+s} = 2.9 \text{ pb for } m(\text{top}) = 175 \text{ GeV}/c^2$$

Single Top Decay at LHC

Decay modes:

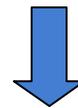
- $W^* : W^* \rightarrow t \bar{b} \rightarrow (l^+ \nu_b) \bar{b}$
- $Wg : q'g \rightarrow t q \bar{b} \rightarrow (l^+ \nu_b) q \bar{b}$
- $W+t : bg \rightarrow t W \rightarrow (l^+ \nu_b) qq'$

1 leptons + MET
 + ≥ 2 jets
 + 1(2) b-tags

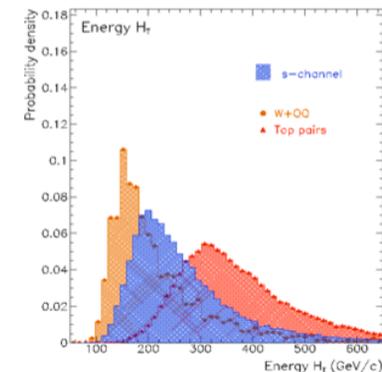
| Channel | $\sigma \times BR(\text{pb})$ |
|---------------|-------------------------------|
| W-g | 54.2 |
| W+t | 17.8 |
| W* | 2.2 |
| ttbar | 246 |
| Wbb | 66.7 |
| W+jets | 3,850 |

Common selection for all 3 single-top samples :

- 1 High p_T Lepton + mET
 → reduce non-W events
- At least two high- p_T jets
 → reduce W+jets events



- Single-top ~22-26%
- ttbar ~ 38%
- WQQ ~ 1.5% , W+njets < 1/1000



T8 Single Top Note

- Contributors

- ◆ K. Assamagan (BNL)
- ◆ M. Barisonzi (NIKHEF)
- ◆ F. Chevallier, B. Clement, A. Lleres, A. Lucotte (LPSC/IN2P3)
- ◆ M. Cobal (INFN)
- ◆ C. Cojocaru, M. Khakzad (U. Carleton)
- ◆ A. Shibata (Queen Mary, U. of London)
- ◆ A. Di Mattia, B.G. Pope, P. Ryan, R. Shwienhorst (Michigan State U.)
- ◆ S. Rolli (Tufts)
- ◆ N. Triplett (Iowa State U.)
- ◆ Editors: A. Lucotte, S. Rolli

<https://twiki.cern.ch/twiki/bin/view/Atlas/T8SingleTop>

Synopsis (preliminary)

- Introduction ... [Simona,Arnaud]
- I. Single-top Phenomenology [Arnaud,Reinhard] :
 - ♦ Single top cross-section
 - ♦ SM backgrounds
- II Single top pre-selection
- L1 Triggering [Bernard,Reinhard,Patrick, Alessandro, others ?]
 - ♦ Inclusive lepton triggers
 - ♦ Jet triggers
 - ♦ Trigger efficiency & redundance
- Preselection [All]
 - ♦ Lepton selection (in link with lepton perf. note)
 - Definition & reconstruction efficiency
 - Selection efficiency
 - ♦ Light jet selection [Mohsen,Claudiu, Akira, Marcello, others?]
 - Definition % recon efficiency : cone size studies (in link with jet perf. note)
 - Threshold optimization (non-top, top pair bckgds)
 - ♦ b-tagged jet selection [Simona,Monica,Mohsen,Claudiu,Akira]
 - Definition % recon efficiency : cone size studies (in link with jet perf. note)
 - Threshold optimization (non-top, top pair bckgds) .
 - ♦ Missing ET
 - ♦ W-transverse mass and /or angular discriminating power [Reinhard, others?]
 - Definition
 - Performance
 - ♦ Leptonic top mass reconstruction [Claudiu, Mohsen, Akira]
 - optimization of the neutrino solution
 - optimization in the M(l**v**) reconstruction
 - Influence of jet cone algorithm & size

Synopsis (cont'd)

- III Single top cross-section measurements
 - ♦ Wg channel analysis
 - standard cut-based selection [Claudiu, Mohsen, Akira, Marcello]
 - NeuralNet? selection [Nathan]
 - systematics : [All the above]
 - b-tagging
 - Jet Energy scale
 - Gluon radiation Modeling
 - Forward jet reconstruction & b-tagging
 - ♦ Wt channel analysis [Marina, Simona, Annick, others ?]
 - Selection & performance
 - systematics :
 - b-tagging
 - Jet Energy scale
 - Gluon radiation Modeling
 - ♦ W* channel analysis [Arnaud, others?]
 - selection & performance
 - systematics :
 - b-tagging
 - Jet Energy scale
 - Gluon radiation Modeling
- IV. Interpretation : top width measurements [Ketevi, others ?]
 - ♦ Selected samples
 - ♦ Performance and systematics
- V. Single top evidence with the early data [Bernard, Reinhard, Patrick, Akira, Alessandro]
 - ♦ Triggering [Bernard, Reinhard, Patrick]
 - ♦ Selection
 - ♦ Influence of b-tagging performance
 - ♦ Background studies [Akira, Reinhard]
 - ♦ Combined Wg and other single top channels ? [Bernard, Reinhard, Patrick, Alessandro, ?], Alessandro, ?]

Several groups/people already active

- Arnaud, Benoit, Florent
 - ◆ -ntupleMaker, common infrastructure
- Akira
 - ◆ -TopView common ntuples
- Simona
 - ◆ - btagging performance all channels
- Mohsen, Claudiu
 - ◆ -reco efficiency and purity of jets all channels
- Nathan -
 - ◆ NN t-channel analysis
- Reinhard, Bernard, Alessandro
 - ◆ - trigger studies

MC sample status

- Signal:
 - ◆ Wt sample 5500
 - ◆ s-channel sample 5501
 - ◆ t-channel sample 5502

} Advanced production

Just started!
- Backgrounds
 - ◆ Top sample 5200/5204/5205
 - ◆ W+jets - lots of discussions
- Most of the current work is related to getting familiar with the infrastructure (for those who are new to the analysis framework) and comparing with Rome samples for those previously active

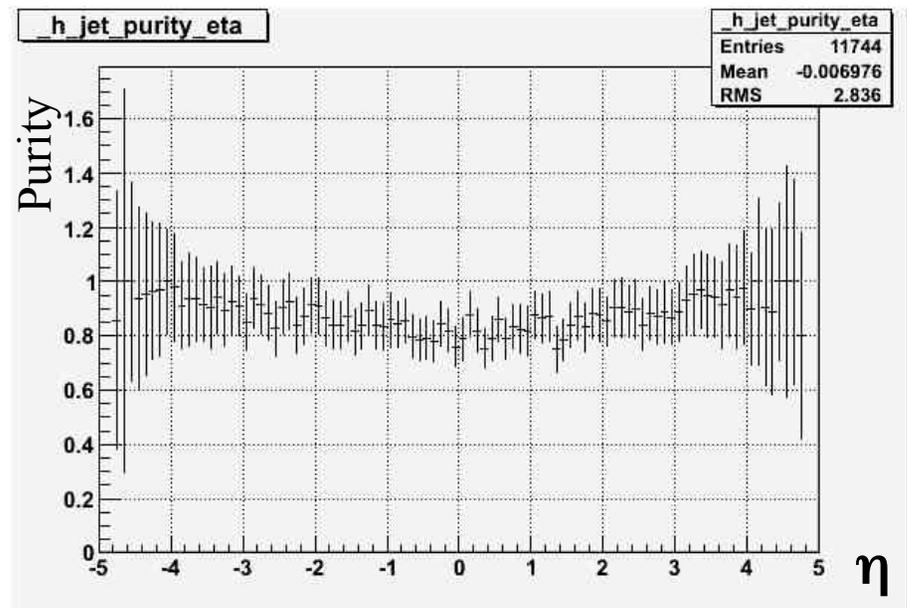
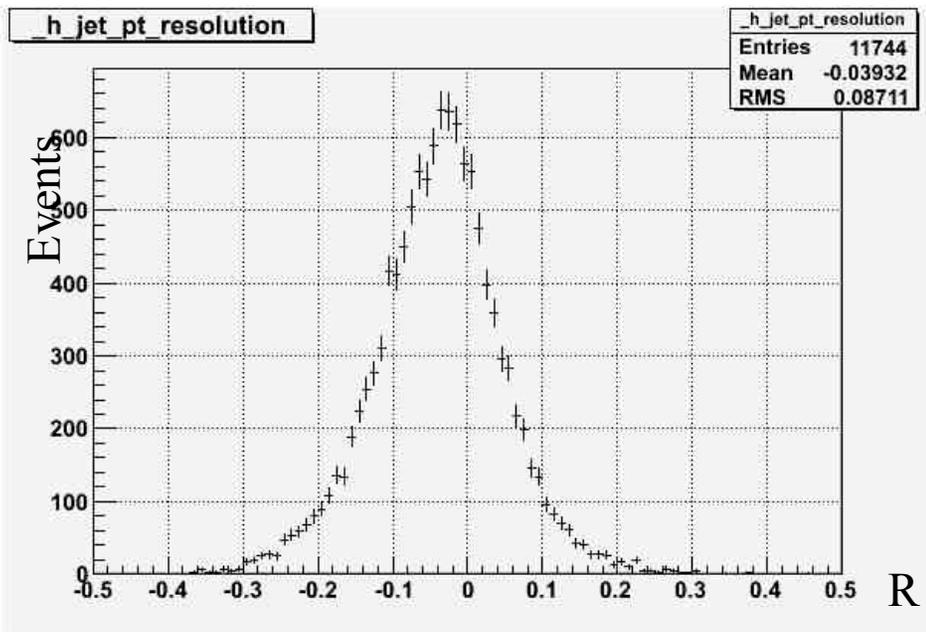
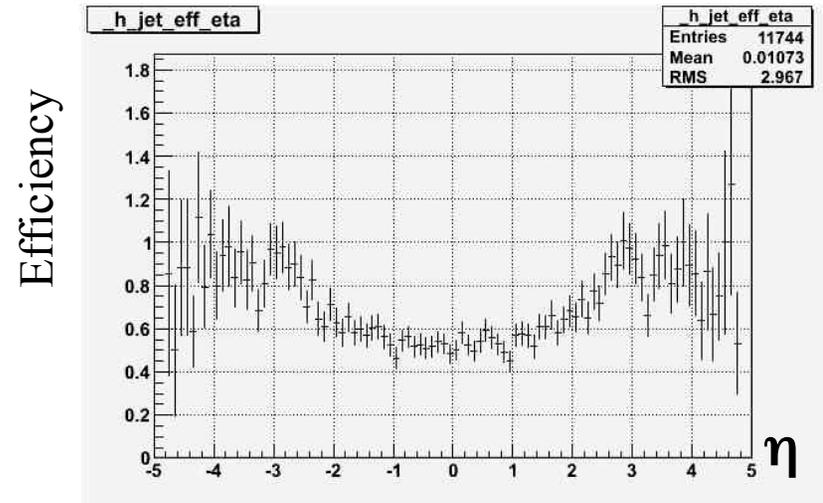
Jet Studies: Definitions

Claudiu Cojocaru, Mohsen Khakzad,
Gerald Oakham, Manuella Vincter
Carleton University

- **Efficiency** = Number of Reconstructed Jets that match to a Truth Particle Jet / Number of Truth Particle Jets (bin by bin - Eta bins)
- **Purity** = Number of Reconstructed Jets that match to a Truth Particle Jet / Number of Reconstructed Jets (bin by bin - Eta bins)
- **Jet matching** = $\Delta R(\text{jet1}, \text{jet2}) < \Delta R_{\text{CutOff}} (0.2 \text{ or } 0.1)$

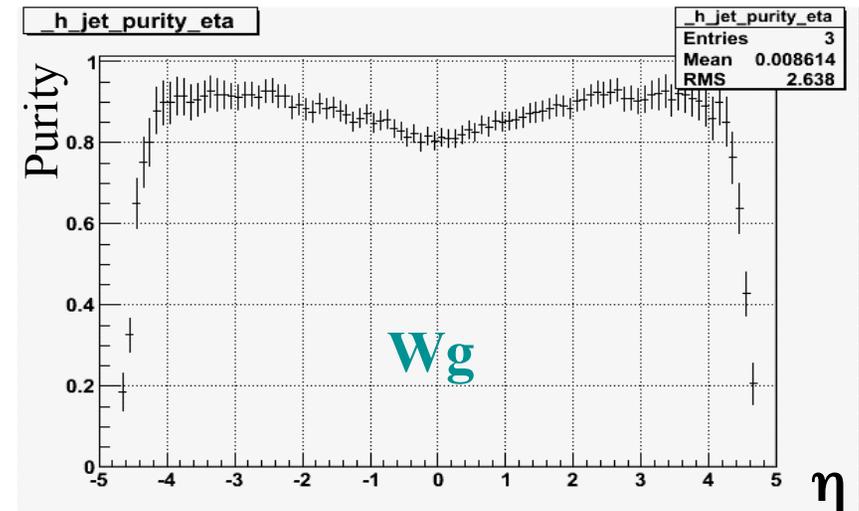
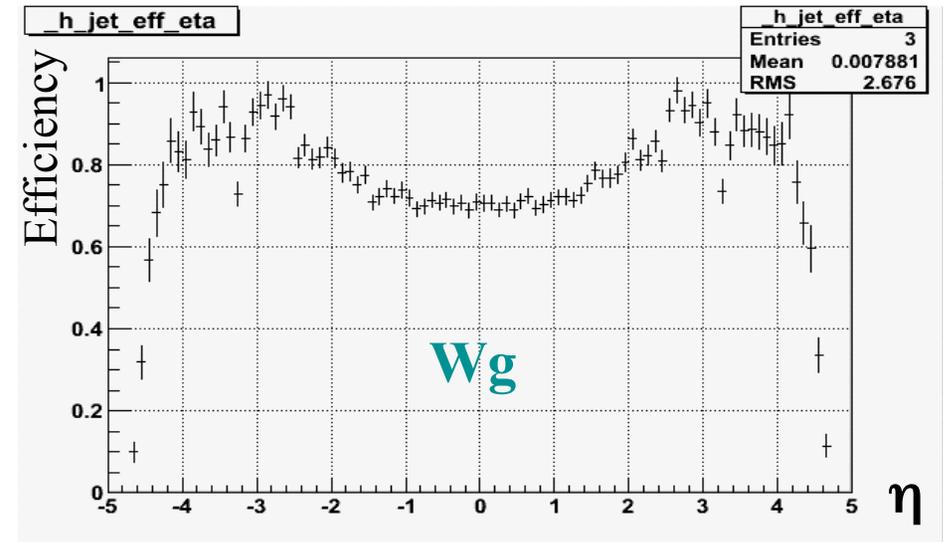
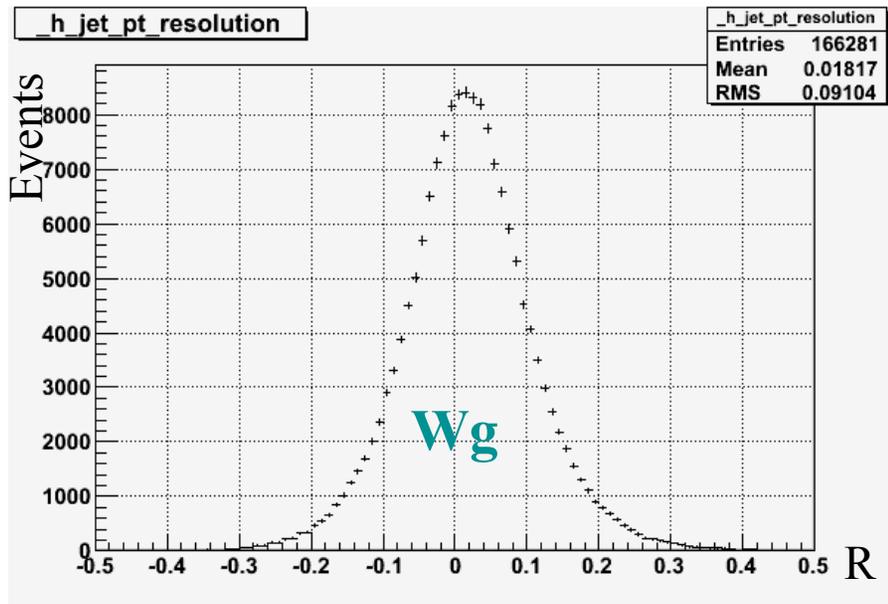
First look at CSC t-channel

- Cuts applied: $Pt > 30$ GeV, $|\eta| < 5.0$
 - CSC samples (7 AOD files ~ 6400 events)!
 - TopView in Athena 11.0.5
 - No backgrounds
 - Jet algorithm: Cone04
 - DeltaRCutOff = 0.1
- Resolution $R = \frac{Pt_{rec,matched} - Pt_{truth}}{Pt_{truth}}$



Compared with Rome data

- **Cuts applied: $Pt > 30$ GeV, $|\eta| < 5.0$**
 - ◆ Rome samples
 - ◆ No backgrounds
 - ◆ Jet algorithm used:
 - Cone04
 - Cone07
 - KT
 - ◆ $\Delta R_{\text{CutOff}} = 0.1$
- **$R = (Pt_{\text{reco_jet}}/Pt_{\text{truth_jet}})_{\text{matched}} - 1$**



B-tagging performance estimators

Simona Rolli
Tufts University

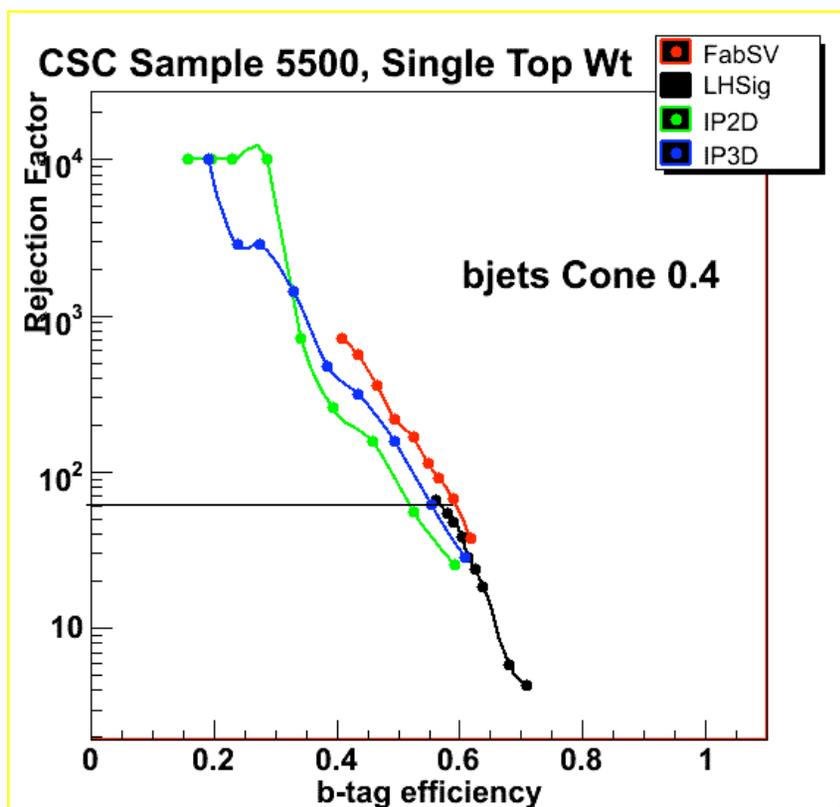
- B-jet efficiency ε_b as function of variable cut:
 - ◆ Denominator:
 - jets defined as b using MC truth
 - with fixed p_T and η cuts ($p_T > 50$ GeV/c, $|\eta| < 2.5$)
 - ◆ Numerator:
 - ditto + cut on a tagging weight
- Light-jet rejection $R_u = 1 / \varepsilon_u$
 - ◆ $R=100$ means 1% mistag rate
 - ◆ light jets: u, d, s, g
- B-jet efficiency as a function of P_T and η
 - ◆ Denominator:
 - jets defined as b using MC truth
 - with fixed cut on weight (SV1 > 3, LHSig > 0.9)
 - ◆ Numerator:
 - ditto + cut on p_T and η

Btagging performance: Wt channel

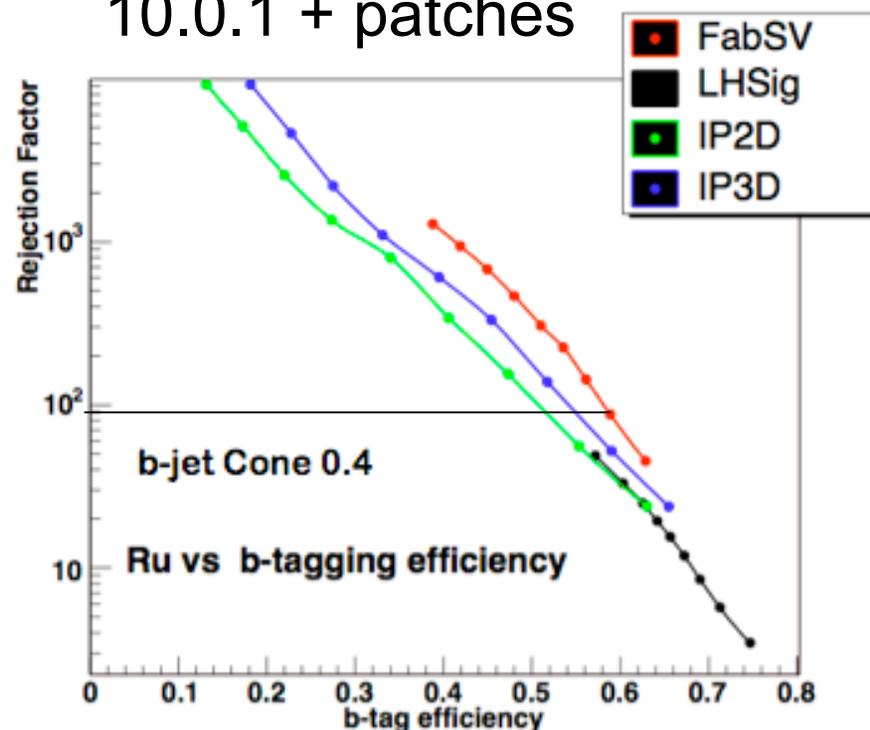
CSC sample 5500, 5000 events

Simona Rolli
Tufts University

11.0.5



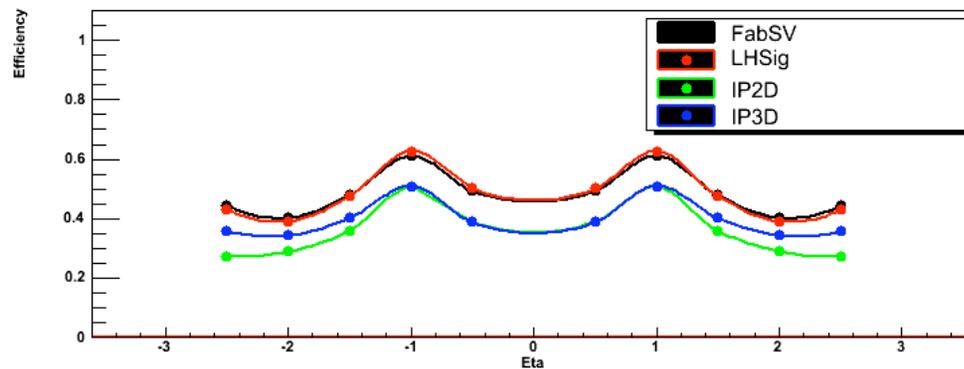
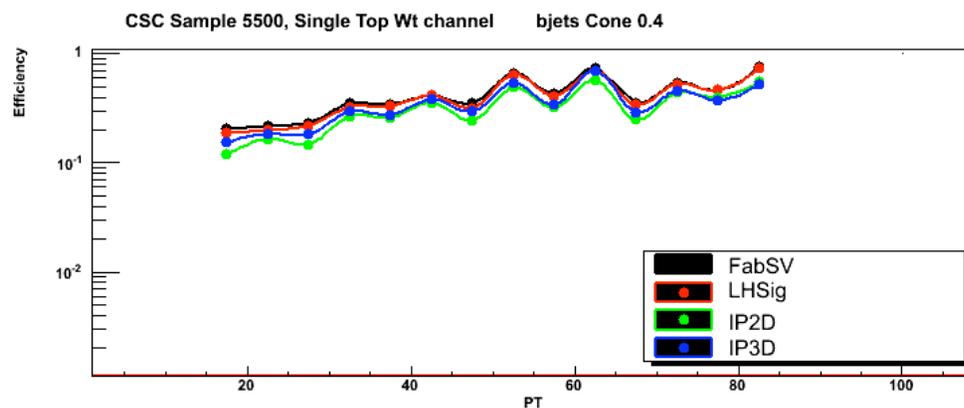
10.0.1 + patches



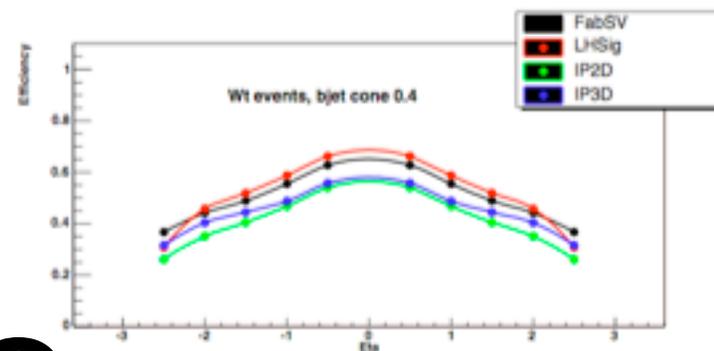
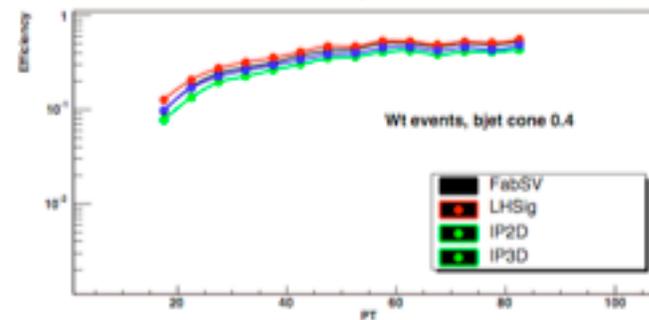
Btagging, Wt efficiencies

Simona Rolli
Tufts University

11.0.5, 5k events



10.0.1 + patches

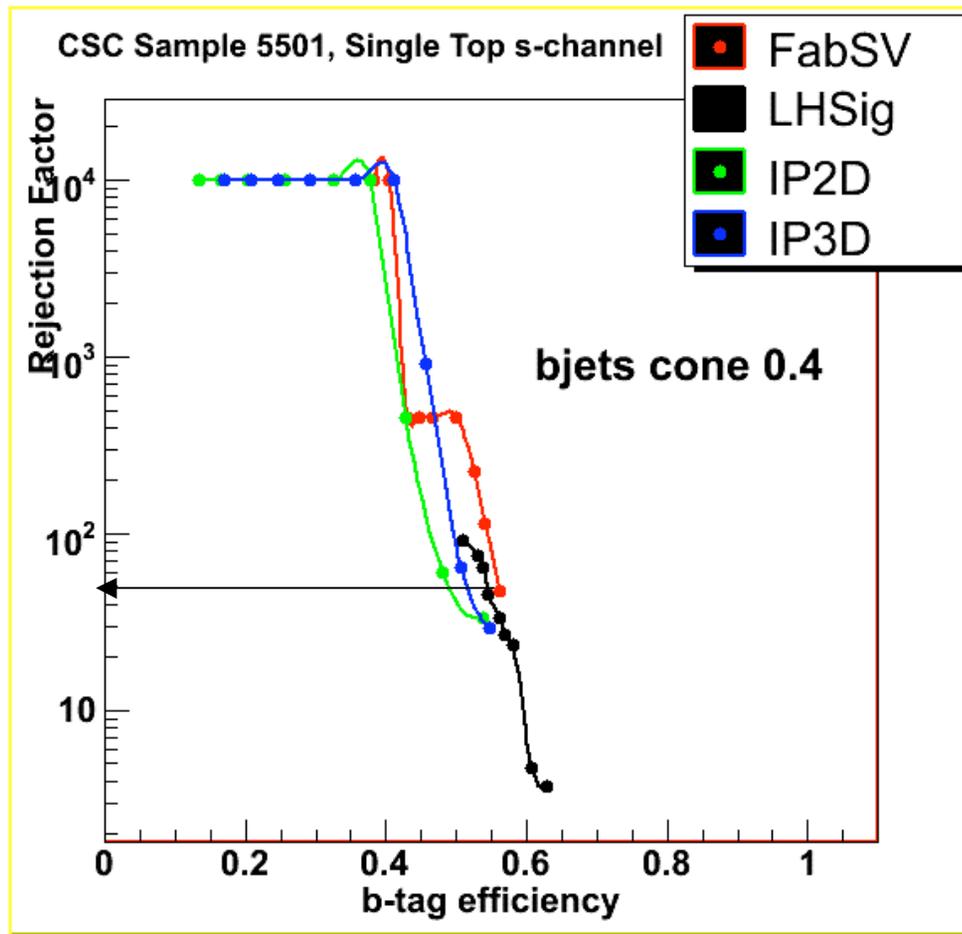


?

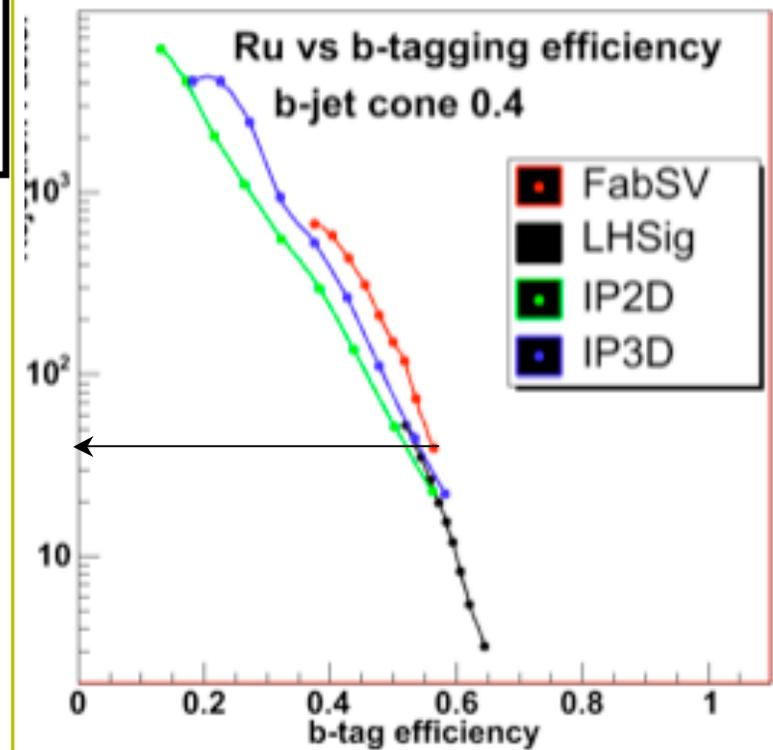
Btagging performance: s-channel

CSC Sample 5501, 50k events
11.0.5

Simona Rolli
Tufts University



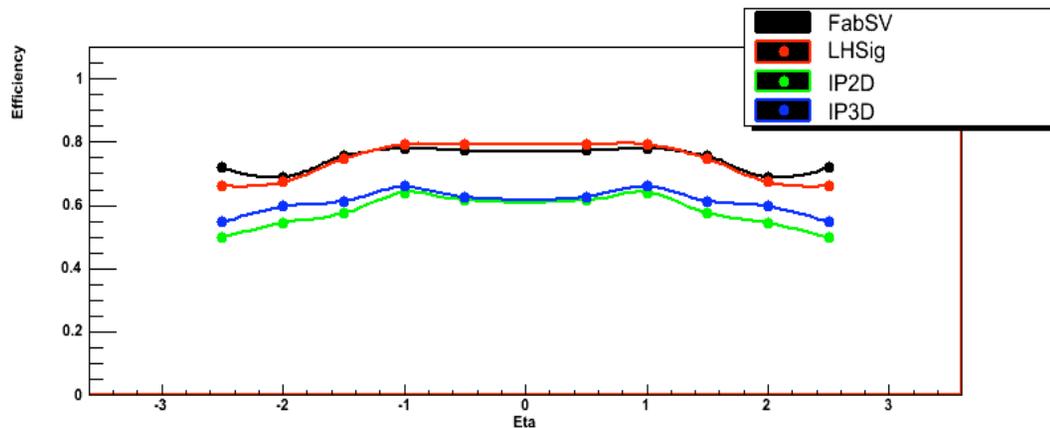
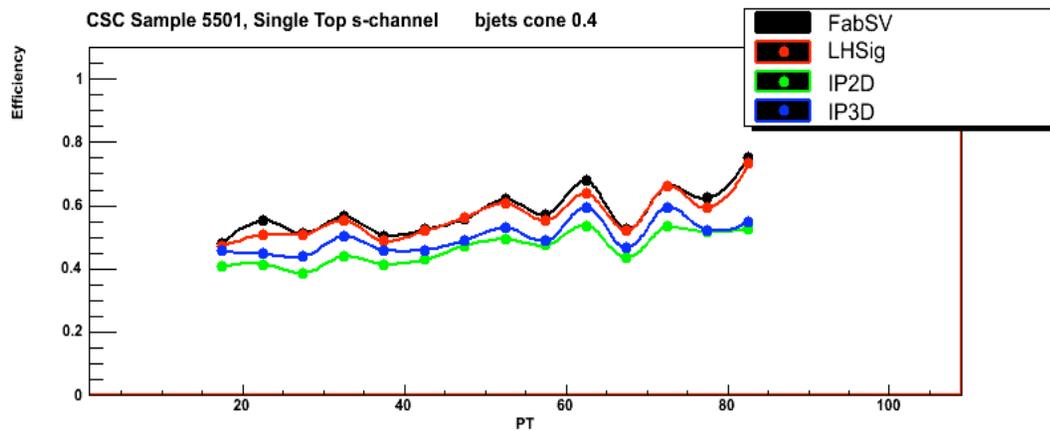
10.0.1 + patches



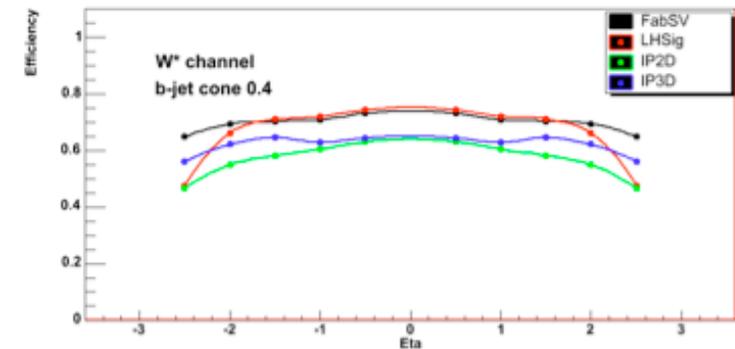
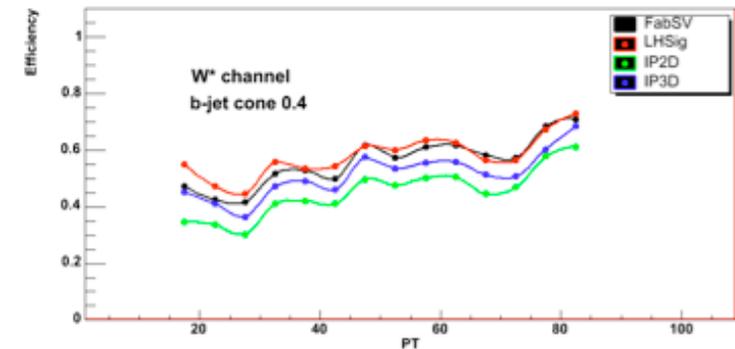
Btagging, s-channel efficiencies

Simona Rolli
Tufts University

11.0.5



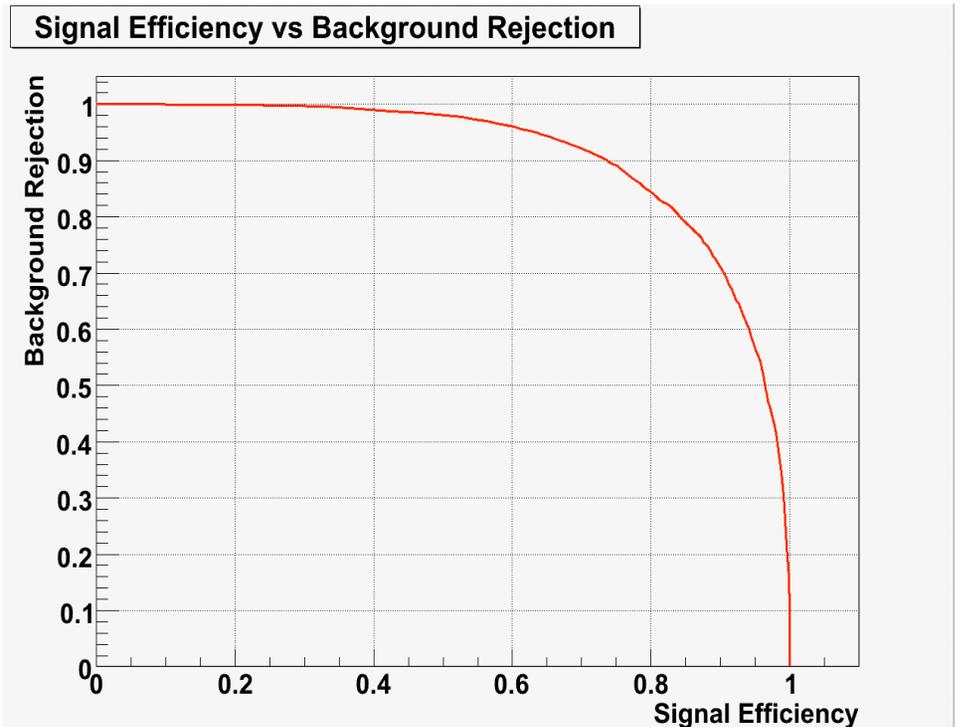
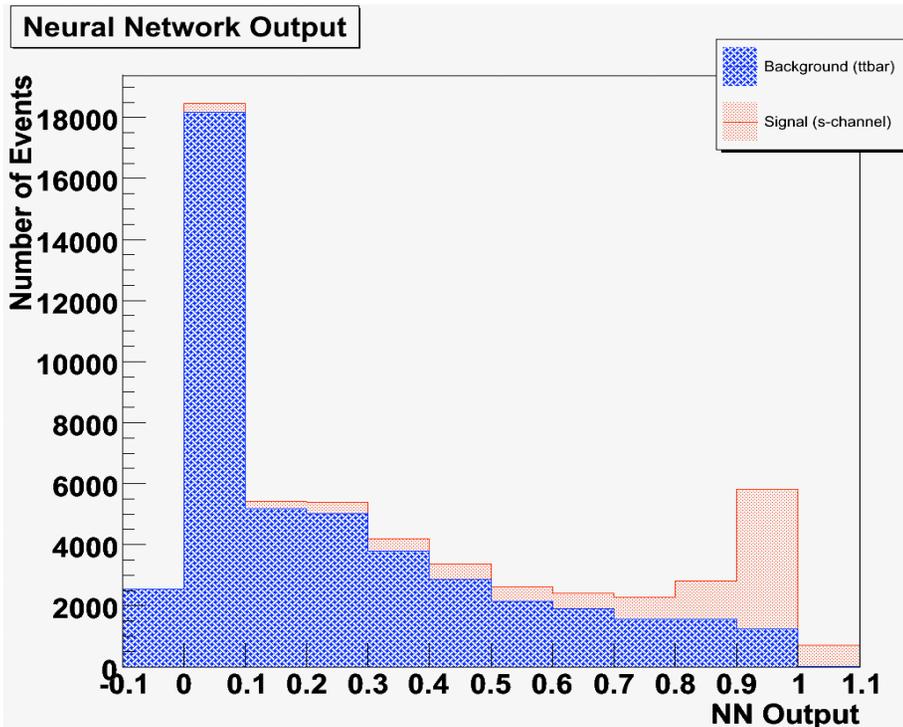
10.0.1 + patches



Neural Network t-channel analysis

Nathan Triplett
Iowa State University

- Still waiting on CSC t-channel data and background data.
 - Until then, Rome data is being used to test analysis code. This should allow for a faster turnaround time once the CSC data is available.
- Example NN output for t-channel vs $t\bar{t}$ background shown below
 - The same techniques will be used for the other backgrounds

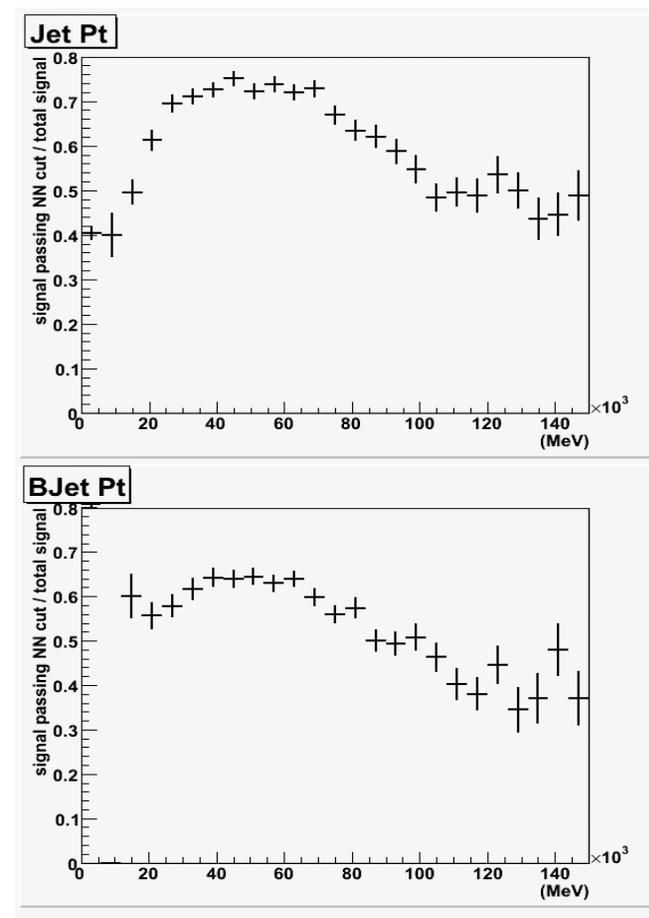


Neural Network t-channel analysis

Nathan Triplett
Iowa State University

- Looking at the correlations of input parameters to the NN can help to optimize the NN
 - Parameters highly correlated in BOTH the signal and background imply only one of those parameters may be needed.
 - A large difference between the correlation of signal and background parameters implies that they are important parameters for both a NN and perhaps for other methods.
- One note of caution relating to the NN!
 - The NN will select an odd subset of the signal, as shown in the figures.
 - This will likely introduce a bias into the sample.
 - Care should be taken if using the NN selected events for other analysis, for instance polarization studies.
 - **This method, however, should be good for a fast discovery of single top.**

The NN selected sample of the t-channel pt spectrum, normalized by the total t-channel sample.



TopView common ntuple

Akira Shibata
Oxford University

- Common ntuples are provided for those who do not want to use their own ntuplizer code: TopView
- The objects definition suggested in the Twiki page is implemented and files are available through dq2 with the following dataset name
 - ◆ user.akirashibata.TopView1111_SingleTop.005001.pythia_minbias.001
 - ◆ user.akirashibata.TopView1111_SingleTop.005501.AcerMC_schan.001
 - ◆ user.akirashibata.TopView1111_SingleTop.005500.AcerMC_Wt.001
 - ◆ user.akirashibata.TopView1111_SingleTop.005205.AcerMCttbar.001
- user.akirashibata.TopView1111_SingleTop.005204.TTbar_FullHad_McAtNlo_Jimmy.001
- user.akirashibata.TopView1111_SingleTop.005202.Mcatnlo_jim_top__leptpt120.001
- user.akirashibata.TopView1111_SingleTop.005201.Mcatnlo_jim_top_pt200.001
- user.akirashibata.TopView1111_SingleTop.005200.T1_McAtNlo_Jimmy.001

Validation plots at:

<https://twiki.cern.ch/twiki/bin/view/Atlas/ST5200Validation>

W+jets generation

Benoit Clement
Grenoble

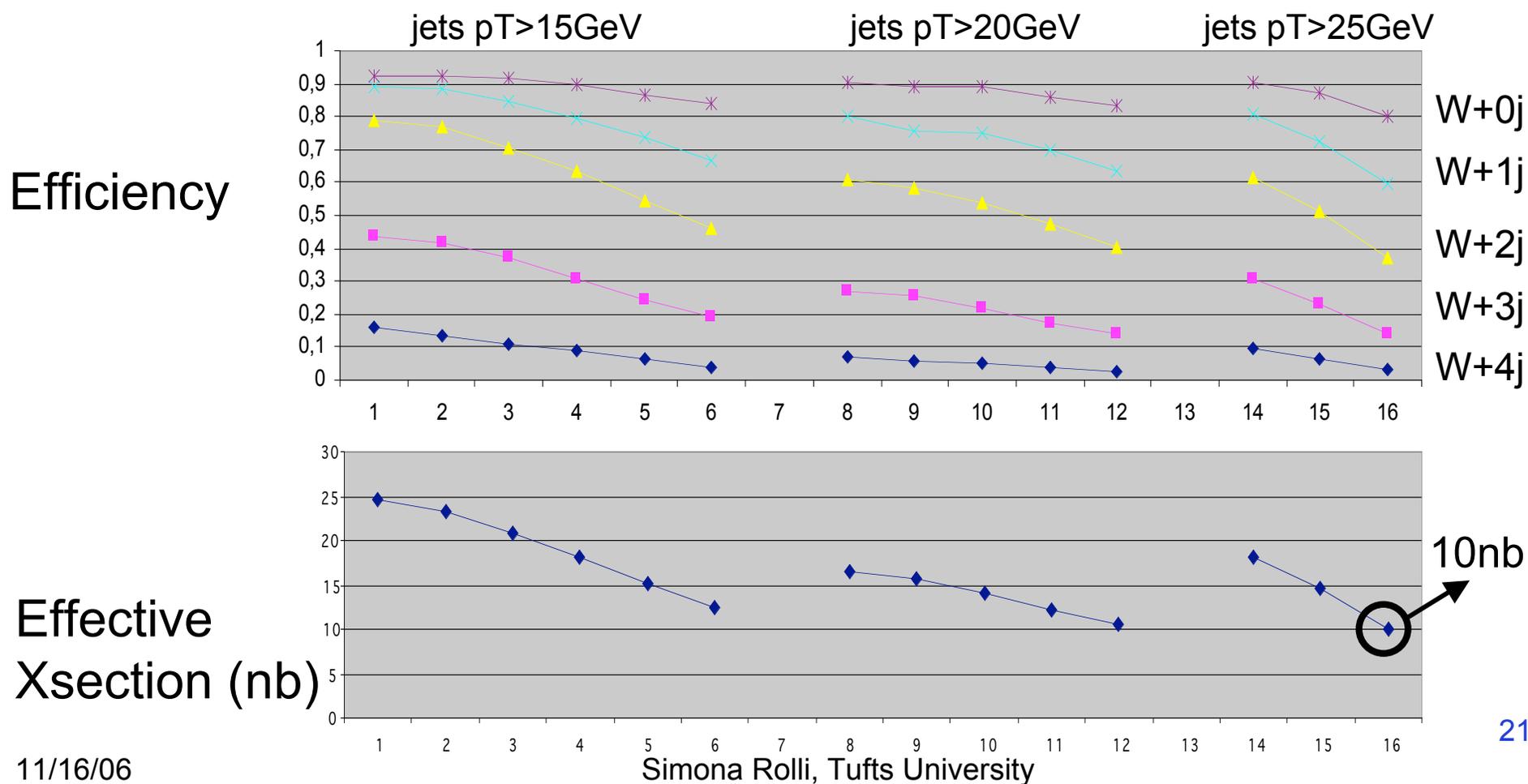
- The samples generated for pair top analyses are inadequate for single top
 - ◆ 3 jets filtering with high P_T threshold
- Several filtering configurations ran
- It might be impossible to produce enough W+jets fullsim with low multiplicities.
- **Proposal:** as many of these events will be killed by tagging, one might choose not to tag the W+jets MC and weight the events by their tagging probability.
- The number of events needed would therefore be reduced by a factor equal to the mistag rate. Then 200k or 300k events could be enough. (note that, for other reasons, this weighting procedure as been extensively used at D0)

Filtering efficiency and Effective X-sections (LO)

At least 2 jets, lepton $P_T > 20$ GeV, MET > 15 GeV

Benoit Clement
Grenoble

jets $P_T > 15 - 25$ GeV Leading jet $P_T(\text{top}) > 15 - 40$ GeV



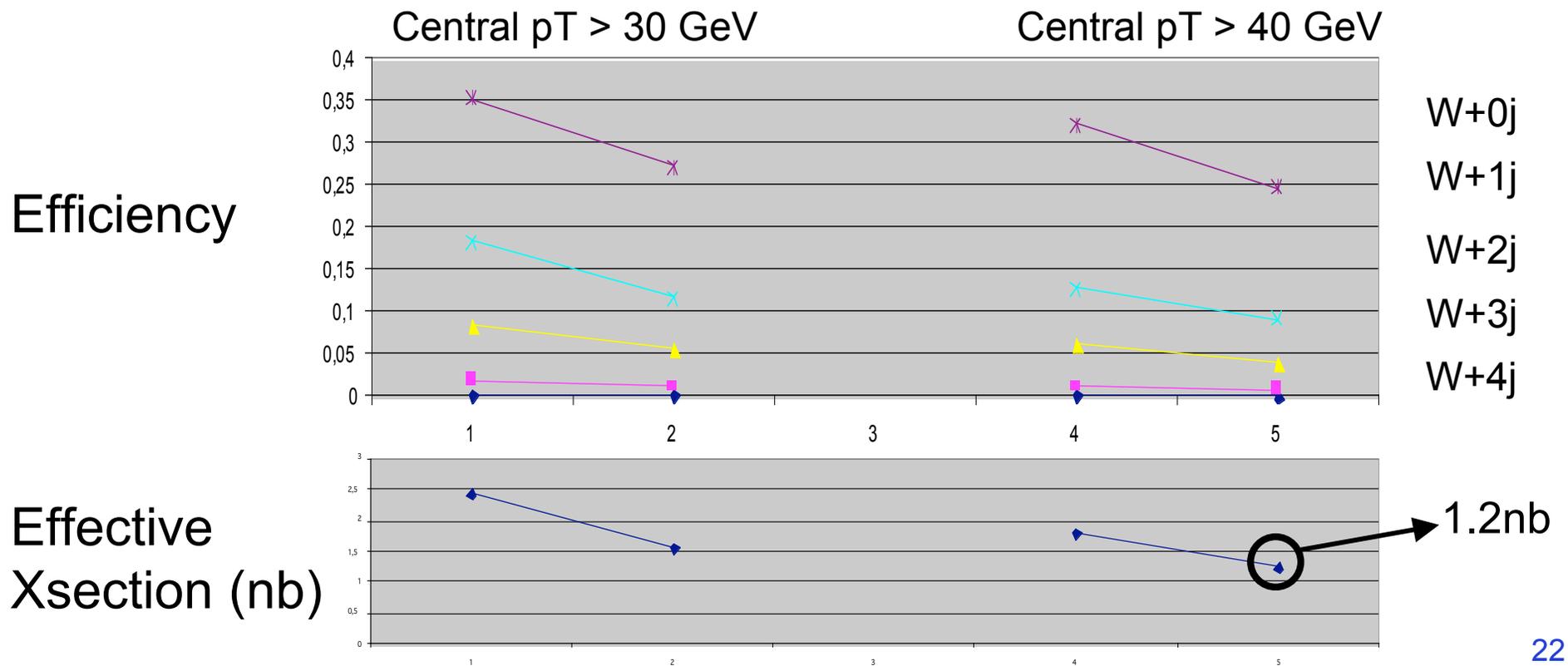
t-channel specific filter

Benoit Clement
Grenoble

At least 2 jets, lepton $P_T > 20$ GeV, MET > 15 GeV

1 central jet (b from top) $P_T > 30 - 40$ GeV, $|\eta| < 2.5$

1 forward jet (light) $P_T > 30 - 40$ GeV, $|\eta| > 2.5$



Final remarks

- MC samples still in production
 - ◆ Particularly true for W +jets background
 - Generation strategy being defined now!
 - Some fastsim AOD available
- Performance notes needed for physics object definition:
 - ◆ High P_T leptons
 - ◆ B-tagging